

Present situation and prospects of forest ecological network in Jilin Province, China

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Abstract: This paper makes a brief introduction of the ecological environment, forestry achievements, and the existing questions of Jilin Province. The task of forest ecological network and eight questions demanding prompt solution were discussed based on the present situation of forestry in Jilin Province. The author also made prospects for future application of bio-technique, information technology, new material technology and nuisance-free forest health technology in forest ecological network.

Keywords: Forest Ecology; Network construction; Jilin Province; Forestry Development; Forest management, New technology

CLC number: S718.5

Document code: B

Article ID: 1007-662X(2002)04-0323-04

General situations of ecological environment

Jilin Province is in the central part of Northeast China (40°52'-46°18'N and 121°38'-131°19'E). Its east-west width is about 750 km and south-north length is 600 km. The total area of the province is 187.4 thousand km², which occupies about 1.95% of the national territory area. The weather, topography, geomorphology, soil, forest vegetation and natural landscape represent obvious regular changes from east to west. Annual mean temperature of the whole province is 2.0 to 6.0°C. Accumulation temperature (above and equal 5°C) is 2 430 to 3 400 °C. Frost-free period is 100 to 150 days. Annual mean precipitation is 350 to 992 mm and annual mean evaporate is 600 to 1 000 mm. From east to west, the climate of the province changes gradually from humid, semi-humid, to semi-arid climate, and frost-free period tends to increase gradually (The Office of Jilin Provincial People Government 1987).

The geomorphology contained 5 types, including mid-high mountain, low-mountain, hilly land, plain, river valley, and 42 sub-types. The topography is high in east and low in west and gradually transits from mountains to plains from east to west, with a decrease in elevation from 2 000 m to 300 m a.b.l.

There are 18 soil types, including dark brown soil, white paste soil, marsh soil, alluvial soil, dark brown forest soil, black soil, chernozem, chestnut soil alkali-saline soil, sandy soil, etc., which are subdivided into 45 sub-types. From east to west, soil types gradually change from dark brown soil and white paste soil to chernozem, chestnut soil and sandy soil (Wang 1992).

The abundant resources of forest, wild animals and plants present vary ecological environment types and bio-diversity. In the middle and lower parts of Changbai

Mountain the forest vegetation type is mainly mixed broad-leaved and Korea pine forest. In the low-mountain and hilly area of the middle-eastern part of Jilin, the originally zonal broadleaved forest has been replaced by the secondary mixed broadleaved forest composed of poplar, birch and oak and the larch plantation (Jia 1994). The Mongolian oak sparse forest in the central part of the province, which is the original zoning vegetation of Song-Liao Plain, has been turned to the farmland shelterbelt mainly composed of poplar. The natural sparse elm forest which is the zoning vegetation in the typically steppe wetland of western parts has been changed to kinds of shelterbelts which are mainly composed of poplar and willow.

Totally there are 3 980 species of forest plants and 437 species of animals. The main forest plants in Changbai mountain that have been known in the world are Korean pine (*Pinus koraiensis*), Korean spruce (*Picea koraiensis*), Little seed spruce (*Picea jazoensis* var. *microsperma*), Khingan fir (*Abies nephrolepis*), Olga bay larch (*Larix olgensis* var. *sylvestrifomis*), Japanese red pine (*Pinus densiflora*), Manchurian ash (*Fraxinus mandshurica*), Manchurian walnut (*Juglans mandshurica*), Amur cork-tree (*Phellodendron amurense*), Mongolian oak (*Quercus mongolica*), Amur linden (*Tilia amuensis*), Ussuri poplar (*Populus ussuriensis*), Korean poplar (*Populus koreana*), and *Batula* spp., *Ulmus* spp. and *Acer*. The vertical distribution of the forest vegetation is like that: secondary mixed broadleaved forest distributes at the altitude below 500 m, mixed broadleaved, Korean pine forest at the altitude of 500 to 1 100m, mountain boreal forest at altitude of 1 100 to 1 800 m, sub-alpine Erman birch forest at 1 800 to 2 100 m, and high mountain tundra zoning distributes at upper 2 100 m.

Achievements and existing problems in forestry development

Jilin Province is a key forest region of China. Its total forest resources and timber yield rank the province second

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Received date: 2002-10-11

Responsible editor: Chai Ruihai

and eighth respectively in the whole nation, which have a prominent strategic position. The current forestry-used land is about 9.83 million hm^2 making up 51.9% of the provincial land, of which forested land is 8.045 million hm^2 and growing stock is 850 million m^3 (Wang 2001). The forest coverage is 42.5%. The annual timber yield is 4.50 to 5.50 million m^3 . In addition, 28 nature reserves have been set up and the total area of those reserves reaches 2.05 million hm^2 , which occupy 10.4% of the total provincial area.

Since 1949, a great number of achievements have been obtained in forestry development, reforestation, greening and forest protection, which had made a significant contribution to ecological environment construction and sustainable developments of social economic for Jilin Province, even for the whole region. Up to the year 2000, Jilin Province had supplied 240 million m^3 of commercial timber to the state. As early as 1995, the target of greening afforestation had been reached two years ahead of time. The tasks of afforestation on usable barren mountains and lands have been finished basically. The forest coverage of middle and western parts of Jilin has been increased from 5.5% in 1978 to 16% now. The farmland shelterbelts play a very important role in improving agriculture ecological environment and in continually raising crop yield. The Changbai mountain forest area is not only a national base for producing timber and forest special products but also a green ecological defense.

Although we have made great achievements on afforestation and on restoration of forest ecosystem, it must be admitted that there still exist very large disparity and lots of problems on constructing forest ecological environment. The following problems needed to be solved: (1) Forest quality degenerates and usable mature and over-mature forest decrease sharply; (2) Forest bio-diversity decreases. Rare tree species and wildlife verge on extinction; (3) Forest ecosystem degenerates and stability is weakened; (4) Forest landscapes tends to be fragmentation; (5) The functions of forest ecosystem are weakened.

Task of forest ecological network

Recently, a decision for constructing an ecological province and a plan for greening and beautifying Jilin earth in ten years have been made by the provincial government. It is a significant event in improving ecological environment and pushing sustainable development of social economy. Greening and beautifying Jilin earth in ten years is a fundamental guarantee of ecological province construction. The key point of realizing this aim is the construction of forest ecological network in Jilin Province.

The Jilin forest ecological network consists of "spot", "line", and "plane". That is to say, consider greening and beautifying cities as spots, shelterbelt of bank and road as lines, and Changbai Mountain forest region in eastern part, secondary forest region in central-eastern part and all kinds of forests in central-western part as plane. Thus a forest

ecological network system which takes trees and forest as main body and combined arbor, bush and grass together is established.

The mode and technique of natural forest restoration in Changbai Mountain area

Changbai Forest area is a state-owned forest region. It owns four of fifth forest resources of Jilin Province. Therefore, the restoration of Changbai Mountain natural forests will be of great importance to the general goal of national ecological environment development, the outlook of main timber production base, as well as the sustainable development of social economy of Jilin Province. The key point of natural forest protection of Changbai Mountain is how to well solve the question on restoration of natural forest. For well carrying out the project of natural forest protection, we should: (1) set up a target-system for the project, (2) adopt management technique by classification, (3) lay down the technical regulation, (4) draw up the enforcement plan which tallies with the actual situation of local conditions, and (5) increase the scientific and technical contains of the project. The integrated and matting techniques and measures for the natural forest restoration of Changbai Mountain must be studied, by using the thought of "near nature forestry" of developed-forestry countries in Europe and America, based on the protection of rare forest species, increase of forest bio-diversity, and enhancement of forest ecosystem stability as well as forest function.

The comprehensive matching techniques of forest ecological engineering for desertification control in western area of Jilin

The western part of Jilin Province is a semi-arid area with crisscross of agriculture and stock raising. Although the construction of "Three-north" protective forest system has been well implemented in this area, the desertification of this area has not been controlled in general yet. The studies on key technique for combating desertification should focus on (1) Investigation of the type, distribution, cause, harm and trend of desertification in western Jilin Province; (2) Selection and introduction of tree and grass species, and the bio-diversity; (3) Restoration and utilization of vegetation in different regions, including key technology of vegetation restoration and increase of utilization value of deserted land; (4) Target-system and monitoring system for control of desertification; (5) Setting up forestry eco-engineering modes and model forests with combination of trees, shrubs and grasses in control of desertification.

Agro-forestry mode and the regeneration technique of farmland shelterbelt in the central area of Jilin

Songliao plain in central Jilin is an important base of commercial crops for both Jilin Province and the whole nation. Great achievement has been obtained in farmland shelterbelt construction in this region (Ba 2000). However,

the farmland shelter forests planted in the early stage are facing with ageing problem and need to be renewed. It is necessary to study the renew techniques urgently. In addition, based on the purpose of farming-forestry, we should establish the farmland protective forest system of ecological economy^[2], and the mode, structure disposition as well as related techniques or measures of the system need to be deeply studied. The compound agro-forestry system should combine the forest-crops, forest-fruit, forest-vegetable, forest-herb medicine, and forest-sideline products together.

The management technique for the low-mountain and hilly area in the middle-eastern part

In the low-mountain and hilly area of the middle-eastern part of Jilin Province, there are large area of secondary forests mainly composed of poplar, birch and oak and some artificial larch forests. On the premise of that soil run off is controlled, the guiding principle of forest management for this area is to promote the succession of natural secondary forest toward the zonal, climatic forest community, through cultivating of forest resources and construction of eco-economy. The construction of eco-economy should take valley system as unit, including integrated development of forest resources and stereoscopic management in wild vegetable, medicine-plants, edible-mushroom, economic-forest, feed-forest and so on.

Town and rural greening and urban forest

Reasonable structure, perfect function, and beautiful landscape are required for a urban green planting system, while for rural greening, it should be realized that village is surrounded by forest, family garden is covered with flowers, meadow and fruit trees, and roads are shaded by trees. The following points and questions should be considered and solved in greening planting and urban forest^[4]: (1). Raising forest coverage and improving greening quality; (2) Solving the question on that greening species is singleness in north region of China and paying attention to the selection of adversity-resistant species; (3) Carrying out the study on the structure and function of urban greening and urban forest ecosystem; (4). Evaluating the benefit of urban greening and urban forest ecosystem; (5) Studying the stability and dominator of urban greening and urban forest ecosystem; (6) Establishing index-system and optimizing indexes for the urban greening and urban forest ecosystem.

Function of green passage and related techniques

The green passage means setting up 5-50 m wide greening belts along the sides of highways, railways, and rivers, which have functions of windbreak, sand-fixing, soil conservation and beautifying environment and take account of eco-economic benefits. By those green passages, the natural forests in eastern area, farmland shelterbelts in central area, windbreak and sand-fixing forest in western

area as well as urban greening could be organically combined to form a green ecological defense. We should perfect the existed green passages, increase the green level and select the suitable greening species or varieties. On the premise of beauty, drought-resistant species should be adopted in planting along the sides of railway and highway, and the wet-resisting species with good function of protection of bank and dyke should be used along the banks of rivers. The structure and function of green passage should compose tree, shrub, and grass. In addition, evaluation of ecological, economical and social benefits of the green passages should be carried out.

Bio-diversity of nature reserves and function of forest parks

Nature reserves and forest parks play important roles in forest ecological network and have significant meanings to improvement of ecological environment as well as sustainable development of social economy of Jilin Province. Changbai Mountain Nature Reserve has been listed as "Human and Biosphere Reservation" by the United Nations Educational, Scientific and Cultural Organization. Xianghai Wetland Reserve and Momoge Wetland Reserves in western Jilin are well known in the world. Research on nature reserves should focuses on structure, function, stability, bio-diversity as well as protection and utilization of nature reserves. For forest park we should lay particular emphasis on tour, sightseeing, and health functions of forest on the premise of protection of ecological environment.

Construction of commercial forest base of superior quality and high efficiency

Here the commercial forest means diversified typical timber forest and economical forest that have definite scale, meet the market requests and have ecological benefits^[3,7]. Since the commercial forest takes profit as purpose and seeks maximal economical benefits, high quality, high efficiency and sustainable management must be taken into account. Industrial timber forest provides raw materials for paper-making and manufacture of particleboard, fiberboard, veneer, wood-wool board and composed timber, while the economical forest takes edible, medicine, feed and other green forest products as management purpose. Tree species used and managing measure for commercial forests should be based on management goal and uses.

Prospects

Forest is an environment which human living depends on. The 21st century is ecological civilization times. Forest is storage of energy, water, carbon, and also is gene bank and ecological defense. Forest ecological network means that based upon a district we study the structural function and benefit of forest from optimum arrangement angle of space pattern and use system engineering principle and method to solve the questions on forest ecology.

Application of bio-technology

The key of setting up forest ecological network system is the selection of tree species and grass species that are suited to drought, barren and saline-alkali sites in west Jilin Province. In addition, the problem of mono-tree species used for urban forest should be settled. Application of bio-technique will supply new tree species and even many kinds of plant species to the construction of forest ecological network. We can adopt the bio-technique, such as tissue culture, gene transformation and industrialization nursery to breed new varieties with all kinds of functions. Chinese researchers have made certain research advances in transgene of pest-resistant, salt-resistant poplar variety. Some insect-resistant poplar varieties have been selectively bred and salt-enduring transgenic plant of *Populus simonii* has been obtained.

Application of information technology

We must adopt the modern information and network technology to build a digital forestry flat and information network, thus realizing scientific and modern management of forest ecological network system. The information technology, particularly the "3S" technology and other hi-tech, provides us scientific means to carry out the analysis of structure of forest ecological network and landscape ecological information. The establishment of digital forestry flat and information network will provide supports to optimizing, readjusting and dynamic control of the forest ecological network system. We must layout scheme and personal training program. The information network system should be established in levels of village (subcompartment), rural area (town, forest farm), county (bureau of forestry), city (canton, bureau) and province (forestry department of provincial government, bureau of forestry management, forestry group). The unit of information should be as small as sub-compartment and the information system should be unceasingly updated and perfected.

Application of new materials

Presently, the survival rate and preserving rate of forestation is not high in semi-arid area of the western Jilin Province. In particularly, on the sand-hill with barren soil and on salt and alkali land, the survival rate is very low. This has become key problems of forest ecological network in the area. Besides selecting drought resistant and salt-tolerance tree species, using water preserving and rooting materials as well as containers have been inexorable trend. On this aspect, foreground of application of new material technology is very amplitude. For increasing the survival rate of afforestation and percentage of forest cover in big extent in the west of Jilin Province, we must use some new materials to solve problem of water preserving and survival rate. Some new materials such as ABT root-growing powder, water reserving agent and solid solidification material, etc. have been put into use in China. However, the achievement that we have made is only pre-

liminary. We believe that in near future, the new material technology will make magnitude breakthrough certainly in overcoming difficulty of forestation in poor plot and improving forest ecological network.

Nuisanceless and health technology of forest

Forest health technology means the measures used for vindicating health of forest and preventing disease, insect, and rat disaster from harming trees. Forest disease and pest, called "non-smoke forest fire", is still serious in China. The lost caused by forest disease and pest is up to 50 billion yuan (REM) per year. In mid-west of Jilin, the occurrence of Longicorn beetle, Matsumura Pine Scale and Pine root scolytid, etc. has spread trend. Maintenance of forest health is to use non-poison (low poison), nuisanceless bio-medicament or ecological measures to prevent disease-insect harm and control weeds and to create a healthy, steady ecological environment favor to tree growth. Jilin Province has made good progress in utilizing Minute egg parasites to prevent *Dendrolimus superans* and in using sex proportion to control rat harm of forest. Although traditional method of chemical prevention can solve some problems, it is also harmful to natural enemy and leads to new ecological disaster. From view of long-term development, we must develop nuisanceless forest health technology (also called ecological regulating and control technology) in order to establish a perfect forest ecological network system.

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